Silica Nanoparticles in Cocontinuous Blends

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Introduction

- Cocontinuous Polymer Blends
  - **Melt blending** two immiscible polymers to form continuous phases
  - **Porous structure** formed with single phase extraction

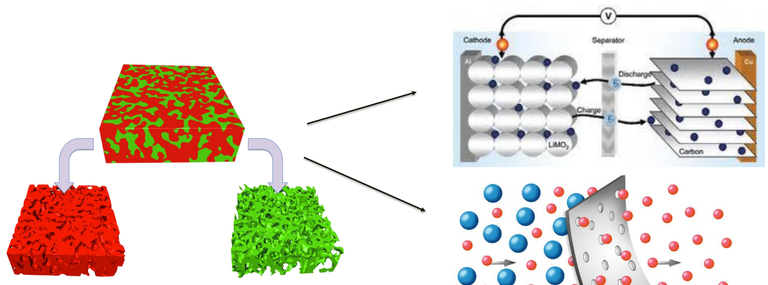


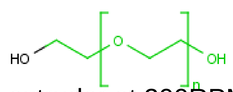
Diagram of cocontinuous polymer blends

Continuous porous structure can be used as separator, gas membrane and etc

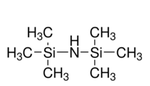
- Motivation:
  - Drive silica nanoparticles to the interface of cocontinuous blends to suppress the coarsening effect
  - Study influence of silica nanoparticles on the morphology and rheological properties of cocontinuous blends

Materials and Sample Preparation

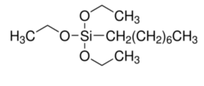
- **Polyethylene (LDPE): Exxon 9955i**
- **Polyethylene Oxide** (SF-PEO)
  - Silica Free PEO from Dow
  - Break down to Mw~100K using extruder at 200RPM, 150ºC



- **Silica nanoparticles:**
  - Colloidal particle
  - Hydrophobic
  - Diameter=110 nm
  - CAB-O-SIL TG C110 modified from hexamethyldisilane
  - CAB-O-SIL TG C190 modified from Octyltriethoxysilane



hexamethyldisilane

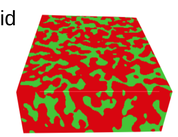


Octyltriethoxysilane

Sample Preparation

Quench with Liquid Nitrogen

DSM Extruder
150 °C, 200RPM

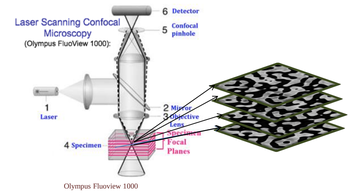


Film of PE/PEO cocontinuous blend

Blend Characterizations:
- Laser Scanning Confocal Microscopy
- Scanning electron Microscopy
- Rheology

1. Pre-blend LDPE with Silica nanoparticle for 3 min
2. blend with PEO for 5 min

Confocal Results

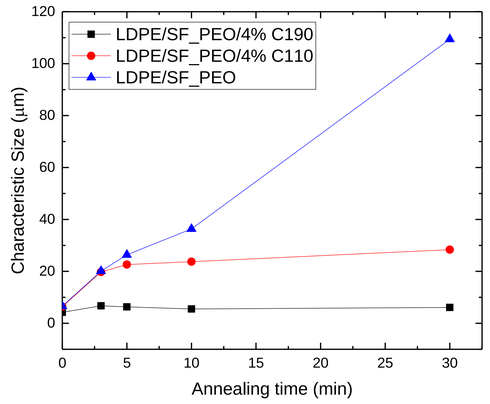


Avizo software

Characteristic size, a:

$$a = 1/Q = V \Big/ \sum_{i=1}^{N} A_i$$

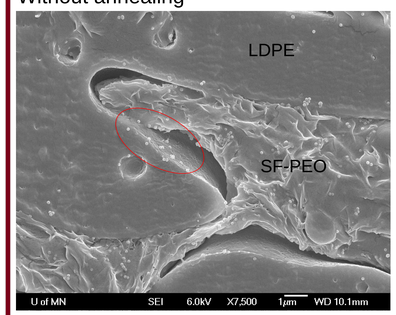
Annealing: heat the sample in hot press at 150ºC



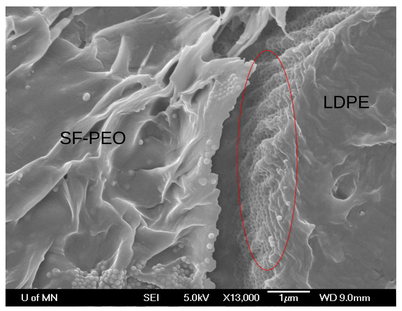
SEM Results

LDPE/SF-PEO/4 wt% C110

Without annealing

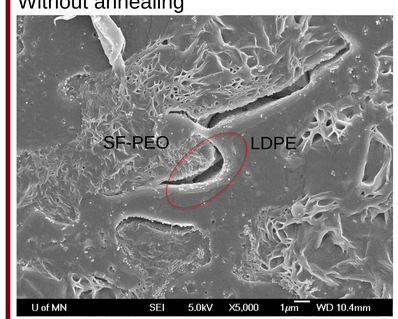


After 30 mins annealing

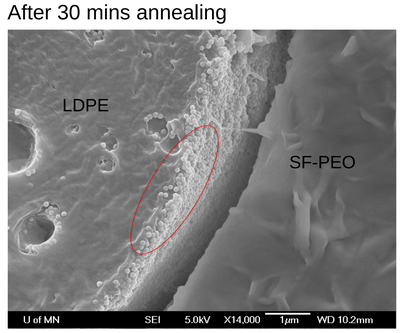


LDPE/SF-PEO/4 wt% C190

Without annealing



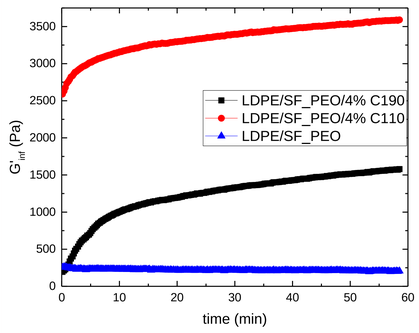
After 30 mins annealing



After 30 mins annealing, silica nanoparticles fully cover the interface

Rheology Results

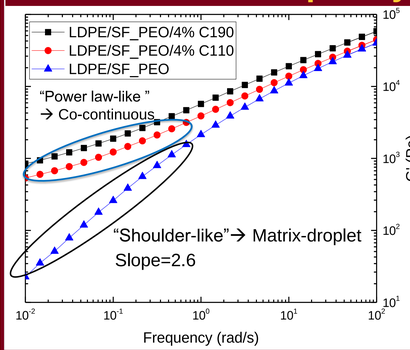
Time Sweep Test



Frequency: 1 rad/s
Time for loading samples (before test) : 7 mins
Strain = 5% **Temp** = 150 ºC

$$G'_{inf} = G'_{blend} - G'_{comp}$$

Frequency Sweep Test



Time for loading samples (before test) : ~1.5 hrs
Strain = 5% **Temp** = 150 ºC

Conclusion and Future Work

- Conclusion
  - Silica nanoparticles stabilized the LDPE/SF_PEO cocontinuous blends
  - More hydrophobic silica nanoparticle is better to stabilize LDPE/SF_PEO cocontinuous blends
- Future Work
  - Pore size distribution calculation
  - Study the influence of the amount of silica nanoparticles in cocontinuous blends

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